Capsule Reviews

The Capsule Reviews are intended to provide a short succinct review of each paper in the issue, in order to bring the content to a wider readership. This issue's Capsule Reviews were compiled by Fairouz Kamareddine. Professor Kamareddine is an Associate Editor of *The Computer Journal* and is based in the School of Mathematical and Computer Sciences at Heriot-Watt University, Edinburgh, UK.

Some Further Theoretical Results about Computer Viruses. Z. ZUO AND M. ZHOU

The last decade has seen a number of theories of computer viruses. In particular, using Turing machines Cohen has shown the undecidability of computer viruses, and using recursive function theory Adelman has shown that the set of computer viruses is $\prod_2$-complete. With the explosion in the number and kinds of computer viruses since, more suitable theories of computer viruses need to be developed. This paper develops general definitions of computer viruses, which include some common kinds of viruses (such as non-resident and resident viruses) and some other viruses that have not yet been found in the real world (e.g. the polymorphic viruses with infinite forms). The existence of various kinds of viruses was established mathematically using the recursive function theory. The authors define the kernel of a computer virus to be the set of mathematical objects, which theoretically determine the virus uniquely, and show that the set of computer viruses with the same kernel is $\prod_2$-complete and that the general set of viruses is $\sum_3$-complete.

Modeling and Analysis of a Scheduled Maintenance System: a DSPN Approach. A. BONDAVALLI AND R. FILIPPINI

The maintenance actions on a system can be corrective or preventive. Corrective maintenance can be minimized by optimally tuning the scheduled maintenance program. This requires an accurate knowledge of the system behavior and an accurate model of the system accounting for component failure rates and modes. From the modeling point of view, a scheduled maintenance system (SMS) can be seen as a multiple phased system (MPS) where phase changes are driven by the SMS. This paper aims to test a new modeling approach based on the deterministic and stochastic Petri net (DSPN). DSPN models are able to cope with the dynamic structure of an MPS and can handle complex models well. This paper considers an SMS problem where the maintenance is executed on-line. The experiments show that the methodology can master real and complex SMS problems as well.

The Green Language Exception Handling System. J. DE OLIVEIRA GUIMARAES

Exception handling systems for languages like Java/C++ do not benefit from object-oriented programming features. In such systems, some standard handling of exceptions may be difficult to enforce and may need special correctness rules. Moreover, the maintenance of such exception handling systems is hard since exceptions are handled via several clauses that are very similar and may all need to be changed if one of them is changed. Furthermore, some dynamic changes may not be possible. These disadvantages have led the author of this paper to design an exception handling system that objectifies the exception handling systems of Java/C++ as much as possible. This exception handling system is based on an object-oriented language called Green. Green uses a type system to check the correctness of the signalling and the handling of exceptions. The exception handling system of Green avoids the above disadvantages and other problems of exception handling in Java/C++. In particular, modularity is preserved in Green's exception handling system whereas it is lost in the exception handling systems of Java/C++.

Extended *k*-nearest Neigbours based on Evidence Theory. H. WANG AND D. BELL

The Dempster–Shafer theory of evidence is a flexible framework for representing and reasoning with imperfect information. The Transferable Belief Method (TBM) is an evidence theoretic k-nearest neighbour (k-NN) method for classification based on the Dempster–Shafer theory. The TBM method assigns beliefs to subsets of classes for each of the k-NNs using the Dempster rule. A method to improve the classification accuracy via an error function is used and is shown to work well with standard k-NN methods. However, the TBM classifier involves combining k belief assignments into a single one and this is computationally expensive. Various methods to speed up this combination process have been proposed in the literature. This paper proposes an alternative method that avoids the need for combination. Instead of the k basic assignments used in the TBM classifier, this method constructs a single basic belief assignment from the neighbours. It is shown that this evidence theoretic classifier extends the standard majority voting based k-NN classifier and is an approximation to the optimal Bayes classifier. Extensive experiments were conducted using the method proposed in this paper. These experiments show that the proposed classifier outperforms many of the existing classifiers.

Regression-Based Self-Tuning Modeling of Smooth User-Defined Function Costs for an Object-Relational Database Management System Query Optimizer. B. S. LEE, L. CHEN, J. BUZAS AND V. KANNOTH

A cost-based query optimization chooses an efficient execution plan that estimates the cost of alternative execution

strategies using predefined cost and selectivity functions. Today's object-relational database management systems (ORDBMSs) allow the users to define their own user-defined functions (UDFs). The query optimizer needs the cost functions of the UDFs, but these functions cannot be known when the DBMS is developed. Hence, this responsibility is passed on to the user who built the UDFs. However, for this, the user must have a thorough knowledge of the query processing mechanism inside the DBMS and this is overwhelming for most users. This paper presents a new approach for modeling the execution costs of UDFs for an ORDBMS. This approach self-tunes the modeling of the costs. The method is based on updating a cost function incrementally based on the actual costs of recent UDF executions, and on facilitating the handling of nominal cost variables by maintaining separate cost models for recently used values of the variables. This leads to an adaptive cost model. As a new batch of data is added, the cost model is adjusted incrementally based on the entire data set from the past. The practicality of the proposed approach is demonstrated by incorporating it into commercial ORDBMSs and using real UDFs supported by the ORDBMS. The experimental results demonstrate the adaptive accuracy of the model.

Efficient Parallel Algorithms for Euclidean Distance Transform. L. CHEN, Y. PAN, Y. CHEN AND X.-H. XU

Distance transforms are a useful tool in digital picture processing. The Euclidean distance transform (EDT) of an image produces a distance map of the same size where the value of each pixel represents the Euclidean distance to the nearest foreground pixel. An exhaustive search for the nearest foreground pixel is a complex procedure. Hence, several parallel algorithms have been proposed for computing EDTs more efficiently. In particular, this paper focuses on EDT algorithms on linear arrays with a reconfigurable pipelined bus system (LARPBS). LARPBS models can exploit the high bandwidth of optical buses used to connect processors. Furthermore, pipelined optical bus systems can support a massive volume of communications simultaneously and are appropriate for applications that involve intensive communication operations. This paper proposes two further EDT algorithms on LARPBS which are the most efficient such algorithms so far. These algorithms exploit the advantages and features of LARPBS.

A Branch-and-Bound Algorithm for the Construction of Reversible Variable Length Codes. H.-W. TSENG AND C.-C. CHANG

Reversible variable length codes (RVLCs) are prefix and suffix codes that provide forward and backward capabilities. RVLCs are suitable for delay constrained real-time applications and error-prone environments. Several algorithms to improve the efficiency of RVLCs have been proposed in the literature. Many of these algorithms suffer from problems related to efficiency. This paper studies the construction of asymmetrical RVLCs for general probability distributions and proposes a very efficient and flexible construction algorithm. This algorithm uses the branch-and-bound technique which efficiently reduces the searching cost. The branch-and-bound technique is a general search method which reduces the search by excluding parts of the search space that cannot give a better solution. The branch-and-bound algorithm is implemented by a breadth first search tree organization where a bounded node helps avoid the generation of subtrees that do not contain a better solution. Experimental results show that the proposed algorithm outperforms other existing algorithms.

A New Intelligent Agent-based Strategy for Constrained Multiple Destination Routing Problems. D. ELLIMAN AND S. M. YOUSSEF

Multicasting is an operation that concurrently sends the same information from a source to a set of destination nodes in a network. To support multimedia applications like teleconferencing and video broadcasting, multicast routing algorithms need to generate routes to reach all destinations and search for good paths to all destinations with reference to certain criteria. This is known as the multiple destination routing (MDR) problem. However, multicast routing algorithms either work too slowly or cannot compute delay-constrained multicast trees at a reasonable cost. Furthermore, heuristic algorithms for the MDR problem either have large complexity, high computational cost or require high storage space. Algorithms based on the branch-and-bound technique work well for small problems but not for larger ones. This paper proposes a new, adaptive and intelligent agent-based strategy for the construction of constrained multicast routing trees, which solves the MDR problem in large networks. The strategy scales well with large dynamic networks and proves to be highly efficient. The proposed algorithm is compared with other known algorithms, and it is shown that it can often find a good solution and adapt quickly to the environment's dynamics.